

PRELIMINARY DATA SUMMARY

February 1993

U.S. Army Engineer Waterways Experiment Station
Coastal Engineering Research Center
Field Research Facility
Duck, North Carolina

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CERC Field Research Facility
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD) of the year 1929. In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

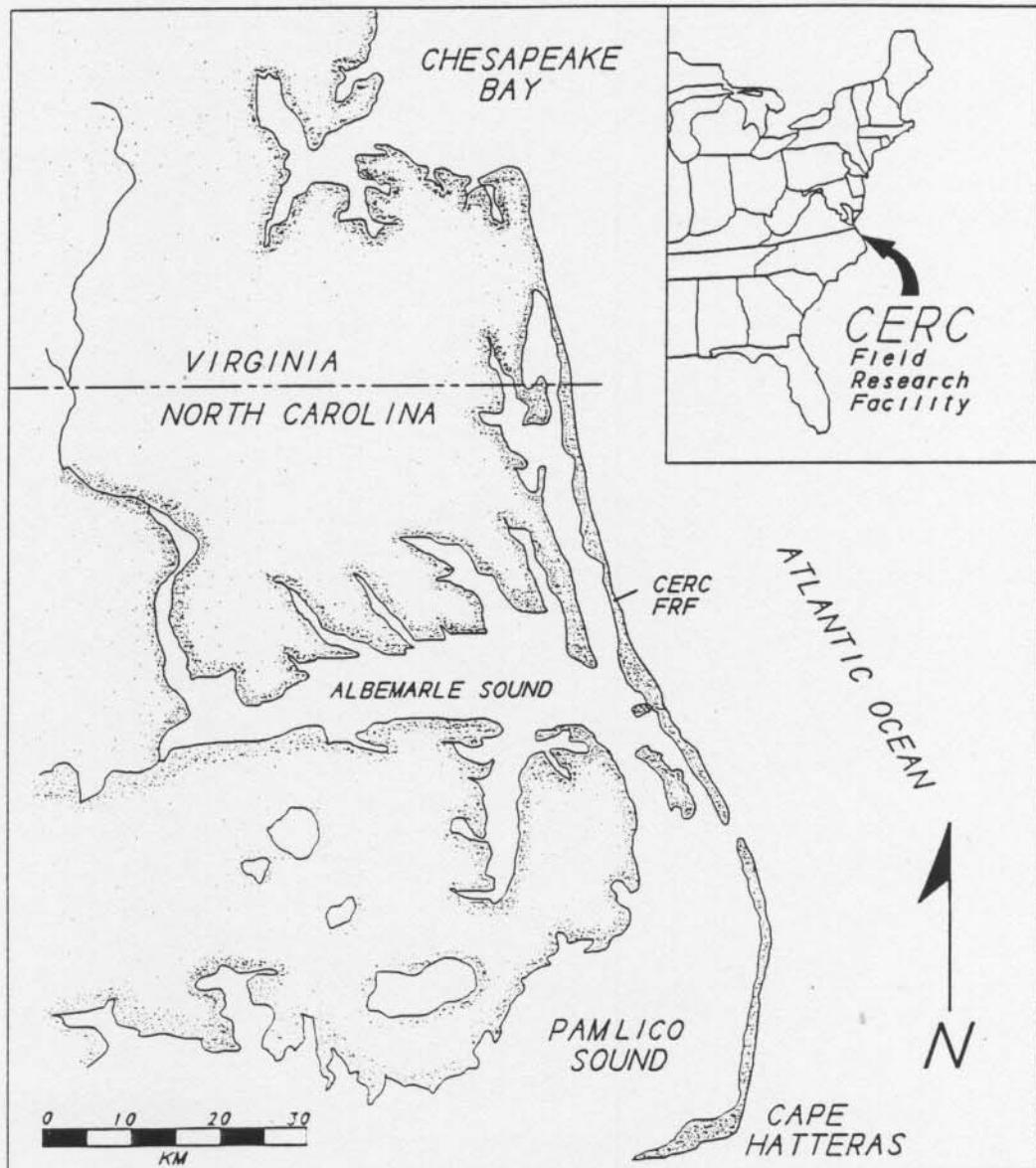


Figure 1. FRF Location Map

Table 1: Instrument Status/Data Availability

FEBRUARY 1993

Gage ID	Description/Remarks	Depth at Sensor		Day of the month																										
				1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7
616	Barometric Pressure		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
604	Precipitation		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
			Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
624	Air Temperature		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	
			Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	
932	Anemometer at seaward end of pier Elevation 19 m (NGVD)		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
			Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
625	Baylor staff at station 18+60 on FRF pier	see Figure 7	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
			Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
511	Pressure gage 243 m north of FRF pier (0.9 km offshore)	Approx. 7.9 m NGVD	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
			Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
630	Waverider buoy 4.0 km offshore	Approx. 17 m NGVD	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
			Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	/	
519	Current meter 320 m north of FRF pier (0.9 km offshore)	see Figure 7	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
			Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
			Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
	Supplemental Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	

Gage Status

Operational = *

Partial = /

Non-Operational = -

Daily Observation

Complete = *

Partial = /

None = -

Data Collected

All = *

Partial = /

None = -

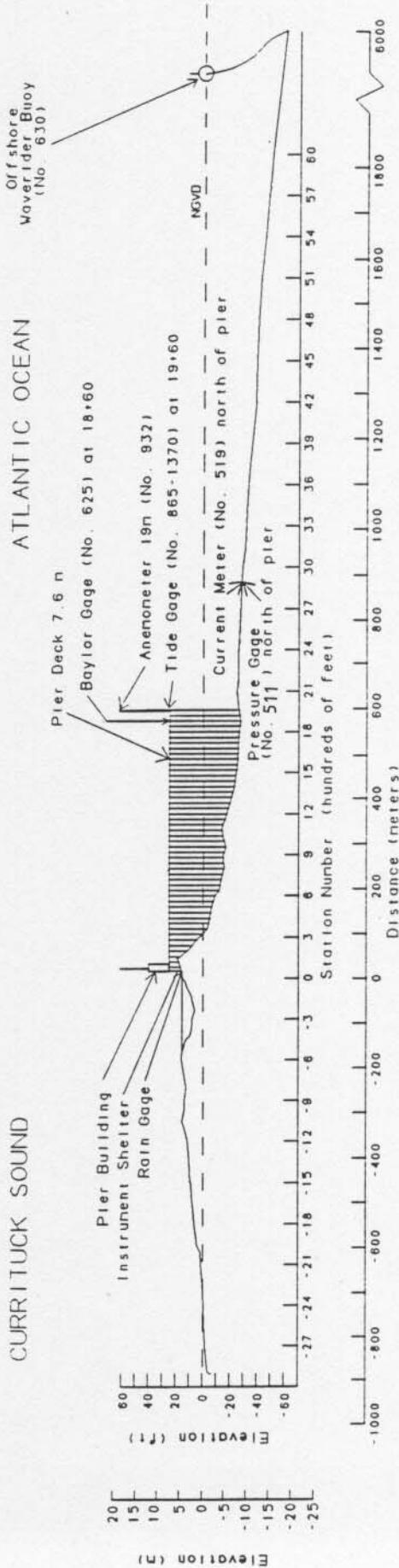
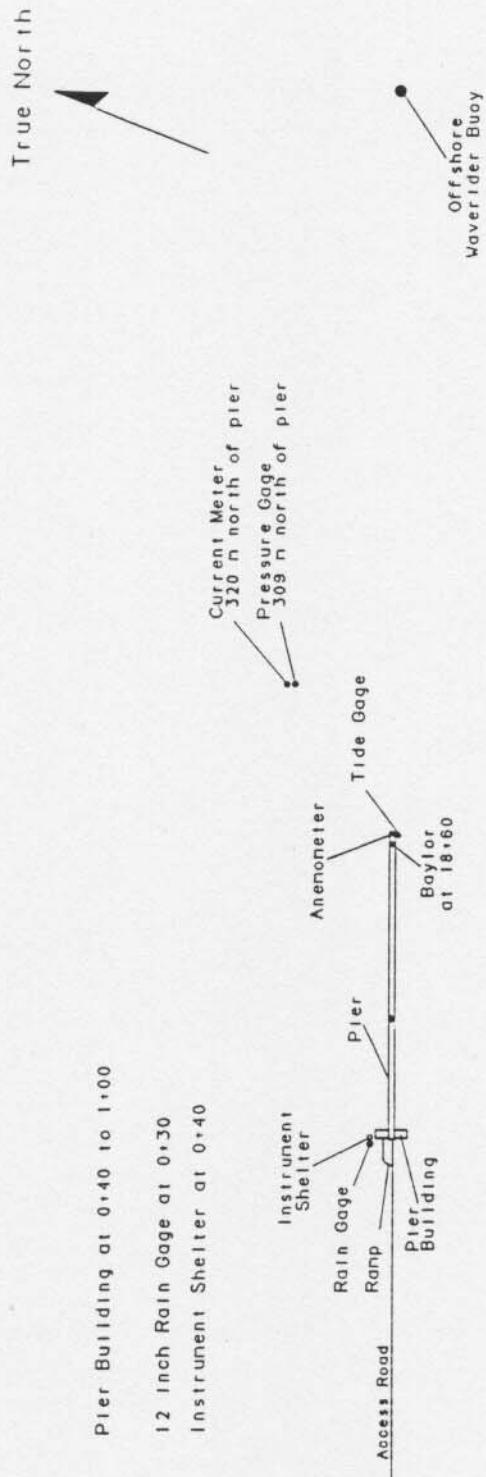


Figure 2. Instrument locations at FRF (all elevations from NGVD, all distances from FRF baseline).

PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 2) using a WeatherMeasure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Wind directions indicate where the wind is coming from. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

Table 2: Meteorological Data

Feb 1993

Day	Hour	Wind Speed m/sec	Wind	Temperature	Atm	Precipitation
			Direction deg TN	deg C	mb	mm
1	100	5	256	8.9	999.8	0
	700	4	214	6.1	1001.2	0
	1300	13	1	7.4	1003.3	0
	1900	17	340	2.1	1011.0	0
2	100	13	328	-2.6	1015.5	0
	700	14	328	-5.3	1018.9	0
	1300	15	333	-2.6	1020.8	0
	1900	9	327	-1.5	1023.6	0
3	100	8	353	-1.7	1023.9	0
	700	3	304	-2.0	1024.1	0
	1300	5	246	5.1	1021.5	0
	1900	4	241	4.9	1019.4	0
4	100	5	243	4.7	1017.3	0
	700	4	272	2.9	1018.9	0
	1300	9	356	7.7	1022.0	0
	1900	10	14	6.6	1025.3	0
5	100	6	26	5.8	1025.5	0
	700	3	302	1.5	1026.0	0
	1300	3	204	8.8	1023.6	0
	1900	4	173	5.2	1019.5	0
6	100	4	228	4.7	1016.7	0
	700	4	245	5.1	1014.9	0
	1300	2	329	11.8	1014.2	0
	1900	12	16	5.3	1017.8	0
7	100	12	15	4.5	1019.5	0
	700	11	19	4.3	1020.8	0
	1300	7	38	6.7	1019.6	0
	1900	7	48	6.5	1017.0	0
8	100	6	356	7.1	1012.8	0
	700	9	357	6.7	1009.2	0
	1300	14	356	13.2	1008.6	3
	1900	11	8	9.3	1013.8	0
9	100	11	358	5.6	1019.0	0
	700	11	12	5.6	1022.9	0
	1300	5	50	7.8	1025.3	0
	1900	5	49	6.6	1025.9	0
10	100	5	353	7.0	1024.2	0
	700	4	12	7.5	1023.1	0
	1300	3	16	10.0	1021.2	0
	1900	4	66	7.7	1020.3	0
11	100	3	52	8.4	1018.1	0
	700	6	7	8.0	1018.1	0
	1300	7	13	8.0	1017.5	0
	1900	10	33	9.6	1015.8	0
12	100	11	35	9.9	1013.5	3
	700	5	9	10.2	1009.6	0
	1300	5	62	8.8	1002.1	0
	1900	7	300	11.7	1001.5	4
13	100	9	282	7.5	1000.9	0
	700	9	236	5.7	1000.3	0
	1300	7	237	8.8	998.2	0
	1900	3	300	8.0	1001.1	0
14	100	7	276	6.0	1003.7	0
	700	8	296	4.4	1008.3	0
	1300	7	348	8.2	1011.2	0
	1900	3	68	5.6	1015.7	0
15	100	8	26	5.3	1019.9	0
	700	7	30	4.6	1023.8	0
	1300	6	60	6.6	1025.2	0
	1900	7	87	5.9	1025.6	0
16	100	8	64	6.7	1023.7	0
	700	5	153	9.8	1019.1	0
	1300	10	156	15.8	1013.7	11
	1900	9	195	17.6	1007.0	5

* electronic problems

(Continued)

(Sheet 1 of 2)

Table 2: Meteorological Data

Feb 1993

Day	Hour	Wind	Wind	Temperature	Atm	Precipitation
		Speed m/sec	Direction deg TN	deg C	mb	mm
17	100	12	286	12.3	1009.5	0
	700	6	303	6.0	1017.2	0
	1300	5	17	7.3	1018.5	0
	1900	4	146	6.3	1018.2	0
18	100	2	259	5.9	1016.3	0
	700	4	324	4.6	1015.0	0
	1300	11	354	2.2	1014.8	0
	1900	5	13	1.5	1015.0	0
19	100	10	355	-0.1	1017.5	0
	700	12	324	-5.0	1022.1	0
	1300	7	340	-2.6	1022.5	0
	1900	3	326	-3.0	1021.5	0
20	100	3	228	-1.0	1020.8	0
	700	6	237	1.9	1019.2	0
	1300	7	234	5.1	1016.9	0
	1900	3	267	3.8	1015.7	0
21	100	1	274	0.7	1016.2	0
	700	5	112	5.3	1015.9	0
	1300	4	135	8.2	1010.6	0
	1900	8	198	13.4	1005.1	0
22	100	7	204	12.2	1002.7	0
	700	7	199	17.5	1001.9	4
	1300	5	231	16.8	999.4	0
	1900	5	267	14.0	1001.7	0
23	100	7	3	6.6	1005.3	0
	700	4	317	5.2	1009.3	0
	1300	8	264	8.9	1009.2	0
	1900	6	301	6.2	1011.1	0
24	100	8	314	1.2	1015.5	0
	700	8	302	-0.4	1018.8	0
	1300	6	282	4.2	1018.7	0
	1900	6	333	2.7	1020.8	0
25	100	9	7	0.0	1025.2	0
	700	8	359	-1.4	1028.6	0
	1300	6	6	0.1	1028.9	0
	1900	4	67	-0.8	1029.2	0
26	100	5	80	1.2	1025.9	0
	700	10	79	5.0	1020.6	0
	1300	12	22	*	1013.9	8
	1900	14	353	*	1011.9	16
27	100	15	354	10.5	1011.6	0
	700	16	347	7.3	1014.5	0
	1300	14	346	4.0	1017.0	0
	1900	11	343	1.6	1019.7	0
28	100	9	348	1.4	1019.3	0
	700	6	309	-1.0	1020.3	0
	1300	10	352	3.5	1018.9	0
	1900	5	338	1.8	1019.1	0
		Resultant	4	Mean	5.5	Total
			345		1016.0	54

* electronic problems

(Sheet 2 of 2)

PART III: WAVE DATA

Wave data are collected from a Baylor staff gage (Gage 625), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 3 hr. The sampling rate is two times per second for five contiguous 34-min records. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to optical disc.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all H_{mo} and T_p values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 3: Wave Data

Feb 1993

Day	Hour	625		511		630	
		Baylor at 18+60 Hmo, m	Tp, sec	Pressure Gage Hmo, m	Tp, sec	Offsho Hmo, m	Wvldr Tp, sec
1	0100	0.28	7.76	0.30	7.76	0.43	7.76
	0700	0.28	7.76	0.27	8.00	0.39	5.82
	1300	1.01	4.83	0.82	4.66	1.31	4.74
	1900	2.39	6.92	2.27	7.31	3.04	7.11
2	0100	2.11	7.53	2.20	7.53	2.65	8.00
	0700	2.06	7.76	2.12	7.76	2.55	8.53
	1300	1.93	6.24	1.98	7.11	2.60	8.53
	1900	1.77	10.67	1.79	10.67	2.23	10.67
3	0100	2.10	12.19	2.14	12.19	2.30	12.19
	0700	2.40	14.22	2.58	14.22	2.41	14.22
	1300	2.51	15.06	2.55	14.22	2.24	14.22
	1900	2.14	15.06	2.04	15.06	1.99	15.06
4	0100	2.05	14.22	1.83	14.22	1.58	14.22
	0700	1.28	15.06	1.41	14.22	1.28	13.47
	1300	1.46	14.22	1.31	13.47	1.51	13.47
	1900	1.31	12.80	1.24	13.47	1.53	13.47
5	0100	1.23	12.19	1.15	12.19	1.44	12.80
	0700	1.03	11.64	0.94	11.64	1.15	12.19
	1300	0.86	11.64	0.77	11.64	0.92	11.64
	1900	0.60	11.64	0.55	11.13	0.65	11.13
6	0100	0.51	10.67	0.45	10.67	0.54	10.67
	0700	0.34	10.24	0.35	10.24	0.39	10.24
	1300	0.27	10.24	0.28	9.85	0.30	10.24
	1900	1.71	6.24	1.51	6.24	1.99	5.95
7	0100	1.74	5.69	1.61	7.31	1.99	8.53
	0700	1.67	9.48	1.43	9.48	1.82	9.14
	1300	1.46	8.83	1.22	9.14	1.47	9.14
	1900	1.28	8.53	1.07	8.26	1.44	8.53
8	0100	1.22	9.85	1.02	8.26	1.31	8.26
	0700	1.14	6.40	1.01	8.83	1.38	5.69
	1300	1.75	5.12	1.46	5.33	2.01	5.45
	1900	1.98	7.11	2.05	7.31	2.35	8.00
9	0100	1.94	8.26	1.77	8.26	2.45	7.53
	0700	1.88	9.48	1.81	9.48	2.00	7.76
	1300	1.75	11.13	1.57	10.67	1.92	9.14
	1900	1.63	10.24	1.51	9.14	1.77	8.26
10	0100	1.39	8.53	1.34	9.14	1.51	9.85
	0700	1.27	10.67	1.20	8.83	1.30	9.14
	1300	0.95	9.48	0.87	10.24	*	
	1900	0.91	9.48	0.88	9.48	*	
11	0100	0.75	9.85	0.73	9.48	*	
	0700	0.71	8.83	0.64	8.83	*	
	1300	0.82	8.53	0.61	8.26	*	
	1900	1.37	5.33	1.10	5.33	1.72	5.12
12	0100	2.37	7.76	2.02	7.76	2.59	7.53
	0700	2.49	10.67	2.67	10.67	3.15	10.24
	1300	2.38	11.13	2.39	11.13	2.70	11.13
	1900	2.10	11.13	1.98	11.13	2.13	11.13
13	0100	1.41	11.13	1.47	11.13	1.71	10.67
	0700	0.95	10.67	1.07	10.67	1.22	10.67
	1300	0.80	10.67	0.78	10.67	0.88	10.24
	1900	0.84	11.13	0.82	12.19	0.96	11.13
14	0100	0.75	12.19	0.75	12.19	0.81	12.19
	0700	0.52	11.13	0.49	11.64	0.58	10.67
	1300	0.92	5.95	0.81	11.13	1.08	6.40
	1900	0.80	11.13	0.72	12.19	0.98	6.74
15	0100	0.79	11.13	0.62	11.64	0.86	10.67
	0700	1.16	6.56	1.00	6.40	1.46	6.24
	1300	0.81	6.40	0.73	6.24	1.20	6.56
	1900	0.77	12.19	0.61	11.64	0.91	6.24
16	0100	0.99	4.34	0.70	4.27	1.13	4.41
	0700	0.95	5.02	0.77	5.12	1.05	5.12
	1300	1.14	8.00	1.12	7.53	1.51	7.31
	1900	1.10	8.26	1.02	8.26	1.47	8.83

* Electronic problems

(Continued)

(Sheet 1 of 2)

Table 3: Wave Data

Feb 1993

Day	Hour	625		511		630	
		Baylor at Hmo, m	Tp, sec	Hmo, m	Tp, sec	Offsho Hmo, m	Tp, sec
17	0100	0.85	8.26	0.80	9.14	1.17	9.14
	0700	0.72	9.48	0.64	9.85	0.83	9.48
	1300	0.76	8.53	0.65	8.83	0.94	8.83
	1900	0.63	8.00	0.59	8.53	0.81	5.22
18	0100	0.52	8.26	0.47	8.83	0.63	7.76
	0700	0.51	8.26	0.40	8.53	0.60	7.53
	1300	1.06	4.49	0.84	4.66	1.36	4.57
	1900	1.09	6.74	0.95	6.92	1.43	7.11
19	0100	1.11	5.12	0.85	5.45	1.37	5.33
	0700	1.69	6.92	1.63	6.74	2.64	6.74
	1300	1.07	7.11	0.97	6.92	1.45	7.31
	1900	0.81	5.95	0.74	7.53	1.00	8.00
20	0100	0.65	6.40	0.58	7.31	0.80	7.11
	0700	0.54	10.67	0.54	10.24	0.67	7.11
	1300	0.65	11.13	0.67	11.13	0.69	11.64
	1900	0.77	10.67	0.76	10.67	0.83	11.13
21	0100	0.82	11.64	0.80	11.13	0.86	10.67
	0700	0.73	11.64	0.88	11.13	0.85	11.13
	1300	0.81	11.64	0.79	11.64	0.92	11.13
	1900	0.78	11.13	0.67	10.67	0.89	10.67
22	0100	0.69	11.13	0.64	10.67	0.78	10.67
	0700	0.64	10.67	0.62	8.26	0.87	8.00
	1300	0.59	10.24	0.57	10.24	0.76	10.24
	1900	0.56	9.48	0.56	10.67	0.72	9.48
23	0100	0.75	11.13	0.59	11.13	0.87	10.67
	0700	0.67	10.24	0.51	9.85	0.74	9.85
	1300	0.55	8.83	0.47	8.53	0.72	9.48
	1900	0.57	8.83	0.47	7.76	0.70	8.00
24	0100	0.75	4.92	0.59	9.48	*	
	0700	0.58	9.85	0.47	9.48	0.80	4.83
	1300	0.50	9.85	0.42	10.24	0.65	8.83
	1900	0.61	4.74	0.48	12.19	0.73	11.13
25	0100	1.16	5.57	0.89	5.45	1.34	5.33
	0700	1.15	6.24	1.23	6.40	1.47	6.74
	1300	0.89	5.22	0.91	6.56	1.21	5.57
	1900	0.79	7.11	0.89	7.31	1.03	7.31
26	0100	0.77	6.56	0.73	6.92	0.89	6.56
	0700	1.16	4.74	1.14	4.41	1.22	4.41
	1300	1.21	5.57	1.22	5.33	1.38	5.69
	1900	2.10	7.11	2.51	7.11	2.71	7.31
27	0100	2.76	9.48	3.13	9.14	3.31	8.83
	0700	2.89	10.24	3.64	9.85		
	1300	2.78	11.13	3.51	10.67	Gage	
	1900	2.65	12.19	3.23	11.13		
28	0100	2.59	11.64	3.18	12.19		
	0700	2.57	13.47	3.02	12.80	Inoperative	
	1300	2.38	14.22	2.85	12.19		
	1900	2.40	13.47	2.80	13.47		
Mean		1.25	9.29	1.22	9.42	1.37	8.85
Std dev		0.67	2.67	0.79	2.44	0.69	2.54

* Electronic problems

(Sheet 2 of 2)

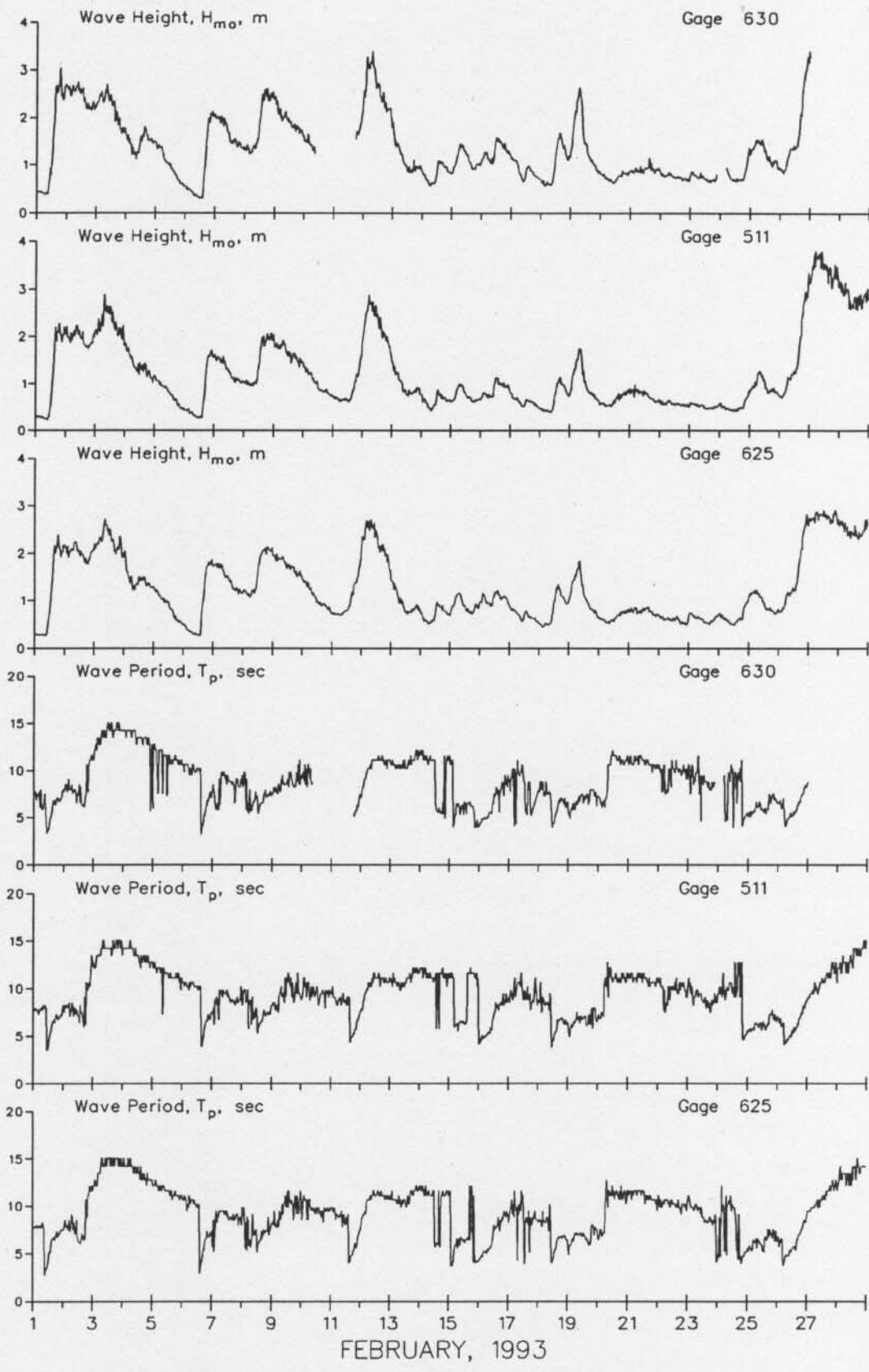


Figure 3. Time history of wave heights and periods

PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards.

IMPORTANT NOTE

Direction resultants regarding the current meter data (gages 519 and 529) may be in error by minus 5 degrees due to a faulty compass reading. Please call us if you must use this data.

Table 4: Current Data
Feb 1993

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter			
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
1	0100-Along Cross Result										1	N
1	0700-Along Cross Result	51	S 8 on		140	47	S 7 on		0	South	1	on 299
1	1300-Along Cross Result	51	169			47	169				2	off
1	1900-Along Cross Result										2	70
2	0100-Along Cross Result										28	S
2	0700-Along Cross Result	102	S 0		177	122	S 37 on				12	off
2	1300-Along Cross Result	102	160			127	177				30	137
2	1900-Along Cross Result										82	S
3	0100-Along Cross Result										30	off
3	0700-Along Cross Result	12	S 6 off		168	44	S 0		21	S North	88	140
3	1300-Along Cross Result	13	133			44	160				65	S
3	1900-Along Cross Result										22	off
4	0100-Along Cross Result										69	141
4	0700-Along Cross Result	11	S 7 off		168	27	N 13 off		79		79	S
4	1300-Along Cross Result	13	129			13	7				27	off
4	1900-Along Cross Result					30					84	141
5	0100-Along Cross Result										76	S
5	0700-Along Cross Result	6	S 0 off		160	5	N N		21		27	off
5	1300-Along Cross Result	6	157			4					81	140
5	1900-Along Cross Result					16	S S				75	S

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Continued)
Feb 1993

Day	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
	Alongshore Cross-shore Resultant	Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
6 0100-Along Cross Result								24	N
								3	on
								24	334
6 0700-Along Cross Result	14 6 15	N off 2	152	0 0 0		4 N		11 2 11	N on 329
6 1300-Along Cross Result								7 1 7	N on 330
6 1900-Along Cross Result								45 19 49	S off 137
7 0100-Along Cross Result								52 21 56	S off 138
7 0700-Along Cross Result	61 15 63	S off 146	165	55 42 69	S off 123	26 S		45 17 48	S off 139
7 1300-Along Cross Result								37 18 41	S off 134
7 1900-Along Cross Result								27 14 30	S off 133
8 0100-Along Cross Result								23 11 25	S off 133
8 0700-Along Cross Result	61 6 61	S on 166	165	29 9 30	S off 143	15 S		19 11 22	S off 131
8 1300-Along Cross Result								52 22 57	S off 138
8 1900-Along Cross Result								29 11 31	S off 139
9 0100-Along Cross Result								50 18 53	S off 140
9 0700-Along Cross Result	76 4 76	S off 157	189	47 16 50	S off 141	25 S		34 14 37	S off 138
9 1300-Along Cross Result								36 13 38	S off 140
9 1900-Along Cross Result								11 9 15	S off 120
10 0100-Along Cross Result								18 8 20	S off 136
10 0700-Along Cross Result	20 0 20	S off 160	165	7 4 8	S off 133	3 S		12 4 12	S off 142
10 1300-Along Cross Result								17 8 19	S off 133
10 1900-Along Cross Result								11 7 13	S off 126

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
Feb 1993

Day	Alongshore Cross-shore Resultant ---- Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
		Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore Depth -5.6m (NGVD) ID #519
11 0100	Along Cross Result									16
		Speed	Dir							S
11 0700	Along Cross Result	13 1 13	S off 154	161	15 0 340		South	30	S	12
										20
11 1300	Along Cross Result									3
										9
11 1900	Along Cross Result									10
										10
12 0100	Along Cross Result									19
										126
12 0700	Along Cross Result	36 5 36	S off 151	177	55 17 58	S on 177	North	13	S	26
										135
12 1300	Along Cross Result									53
										25
12 1900	Along Cross Result									59
										135
13 0100	Along Cross Result									57
										S
13 0700	Along Cross Result	0 0 0		166	0 0 0		North	13	S	28
										134
13 1300	Along Cross Result									45
										15
13 1900	Along Cross Result									47
										142
14 0100	Along Cross Result									41
										S
14 0700	Along Cross Result	0 0 0		177	34 5 34	S off 151	North	19	S	14
										2
14 1300	Along Cross Result									14
										147
14 1900	Along Cross Result									31
										7
15 0100	Along Cross Result									32
										147
15 0700	Along Cross Result	68 0 68	S off 160	189	55 0 55	S off 160	North	13	S	14
										2
15 1300	Along Cross Result									8
										off
15 1900	Along Cross Result									13
										34

KEY = All speeds in cm/sec
N = Northward, Shore parallel
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on = onshore off = offshore

Table 4: Current Data (Continued)
Feb 1993

Alongshore Cross-shore Resultant ---- Time Day	Pier Measurements						Beach Measurements			Current Meter	
	Dye at (579 m) (surface)	Distance from Baseline (m)	Dye at Mid-Surf Zone (surface)			(500m Updrift)			0.9 km Offshore Depth -5.6m (NGVD) ID #519		
	Speed	Dir	Speed	Dir	Location	Speed	Dir	Speed	Dir		
16 0100-Along Cross Result								23	S		
								12	off		
								26	133		
16 0700-Along Cross Result	0		177		12 N			18	S		
	0			8 off				17	off		
	0	0	15	15	South			24	117		
16 1300-Along Cross Result								12	S		
								4	off		
								12	142		
16 1900-Along Cross Result								10	S		
								4	off		
								11	136		
17 0100-Along Cross Result								2	S		
								1	on		
								2	192		
17 0700-Along Cross Result	34	S		28	S			24	S		
	10	off	165	3	off	North	18 S	11	off		
	35	143		28	154			27	135		
17 1300-Along Cross Result								21	S		
								10	off		
								23	135		
17 1900-Along Cross Result								11	S		
								6	off		
								13	133		
18 0100-Along Cross Result								11	N		
								3	on		
								11	325		
18 0700-Along Cross Result	13	S		11	S			7	N		
	1	off	152	0	North	15 S		1	on		
	13	157		11	160			7	332		
18 1300-Along Cross Result								20	S		
								6	off		
								21	142		
18 1900-Along Cross Result								28	S		
								9	off		
								29	142		
19 0100-Along Cross Result								29	S		
								9	off		
								30	143		
19 0700-Along Cross Result	76	S		102	S			59	S		
	8	off	177	91	off	North	40 S	20	off		
	77	154		137	118			62	142		
19 1300-Along Cross Result								43	S		
								13	off		
								45	143		
19 1900-Along Cross Result								36	S		
								12	off		
								38	142		
20 0100-Along Cross Result								20	S		
								6	off		
								21	144		
20 0700-Along Cross Result	0			0				5	N		
	0		152	0	North	7 S		4	on		
	0	0		0				6	302		
20 1300-Along Cross Result								9	N		
								9	on		
								13	296		
20 1900-Along Cross Result								4	N		
								2	on		
								4	309		

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Continued)
Feb 1993

Alongshore Cross-shore Resultant ---- Time Day	Pier Measurements						Beach Measurements (500m Updrift)			Current Meter	
	Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
21 0100-Along Cross Result										20	S
21 0700-Along Cross Result	17 5 18	N on 323		152	38 2 38	N off 343		14	N	11 23 5	off 131 S
21 1300-Along Cross Result										1 5 5	S on 241
21 1900-Along Cross Result										1 8 8	N on 255
22 0100-Along Cross Result										2 7 7	N on 266
22 0700-Along Cross Result	8 10 13	N off 31		165	17 6 18	N on 321		6	N	0 3 3	on 250 S
22 1300-Along Cross Result										1 1 2	S on 214
22 1900-Along Cross Result										1 3 3	N off 55
23 0100-Along Cross Result										14 8 16	S off 131
23 0700-Along Cross Result	13 6 14	S off 133		179	21 7 22	S off 141		6	S	13 18 22	S off 106
23 1300-Along Cross Result										1 3 3	S on 233
23 1900-Along Cross Result										11 5 12	N on 313
24 0100-Along Cross Result										21 6 21	S off 143
24 0700-Along Cross Result	23 18 29	S off 123		154	19 10 21	S off 133		13	S	8 3 8	S off 142
24 1300-Along Cross Result										9 3 9	S off 143
24 1900-Along Cross Result										3 1 4	S off 142
25 0100-Along Cross Result										22 8 23	S off 140
25 0700-Along Cross Result	102 0 102	S off 160		187	87 0 87	S off 160		25	S	26 10 28	S off 140
25 1300-Along Cross Result										31 11 33	S off 141
25 1900-Along Cross Result										24 16 29	S off 126

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Concluded)
Feb 1993

Day	Alongshore Cross-shore Resultant ---- Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter			
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
26	0100-Along Cross Result										18	S
											9	off
											20	132
26	0700-Along Cross Result	0			173	24	N		34	N	10	S
		0				15	off				3	off
		0	0			28	11				10	145
26	1300-Along Cross Result										19	S
											8	off
											21	136
26	1900-Along Cross Result										50	S
											16	off
											53	143
27	0100-Along Cross Result										86	S
											26	off
											90	143
27	0700-Along Cross Result	122	S		189	152	S		8	S	104	S
		0				0					36	off
		122	160			152	160				110	141
27	1300-Along Cross Result										87	S
											27	off
											91	143
27	1900-Along Cross Result										58	S
											18	off
											61	142
28	0100-Along Cross Result										34	S
											4	off
											34	153
28	0700-Along Cross Result	38	S		187	68	S		13	N	17	S
		15	off			10	off				6	off
		41	138			68	151				18	141
28	1300-Along Cross Result										51	S
											16	off
											54	143
28	1900-Along Cross Result										42	S
											11	off
											43	146

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PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 5: Supplemental Observations

Feb 1993

Day	Time	Wave Approach		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End		
		Angle at Pier End deg from True N Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	1200	10			52	7.2	1.0250	0.9
2	0805	45	160	35	247	5.6	1.0249	0.9
3	0750	65		70	372	5.0	1.0228	0.9
4	0745	65			199	5.1	1.0227	1.2
5	0800	55			157	5.3	1.0227	0.9
6	1120	none visible			144	6.1	1.0230	1.2
7	0930	30		65	183	6.1	1.0238	0.9
8	0817	40	160	65	127	6.7	1.0232	0.9
9	0747	60	345	65	211	5.3	1.0216	0.9
10	0755	75			163	5.6	1.0230	0.6
11	0750	40		60	138	5.7	1.0232	1.5
12	0820	65		65	343	5.8	1.0211	1.5
13	0815	65		60	167	5.7	1.0234	0.3
14	1540	30		95	164	6.1	1.0244	1.2
15	0850	35		50	158	5.3	1.0228	1.8
16	0755	70	350	75	146	5.3	1.0211	1.5
17	0745	20			151	6.3	1.0259	0.6
18	0750	10			116	6.3	1.0256	1.5
19	0810	25		25	293	4.4	1.0227	0.9
20	0845	70	25		157	4.4	1.0222	0.9
21	0935	75	95	75	167	5.0	1.0238	2.1
22	0800	95	145		132	6.1	1.0250	1.8
23	0820	25	355		134	5.7	1.0239	3.4
24	0750	15	140		120	5.6	1.0246	2.4
25	0755	25	345	30	129	5.0	1.0249	1.2
26	0750	55			169	5.0	1.0227	1.8
27	0855	60		60	226	4.4	1.0205	0.3
28	0910	65	5	60	317	4.4	1.0224	0.3

PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

Table 6: Water Levels,m NGVD

		Feb 1993			
Mid-Cycle Day	Time	Low	High	Mean	Range
1	542	-0.22	0.46	0.10	0.68
1	1807	-0.22	0.67	0.29	0.89
2	632	-0.12	0.78	0.33	0.91
2	1857	-0.26	0.54	0.17	0.80
3	722	-0.27	0.73	0.23	1.00
3	1948	-0.45	0.51	0.08	0.96
4	813	-0.34	0.75	0.22	1.09
4	2038	-0.31	0.64	0.16	0.95
5	903	-0.45	0.87	0.21	1.32
5	2128	-0.63	0.57	0.00	1.20
6	954	-0.64	0.79	0.10	1.43
6	2219	-0.34	0.92	0.31	1.26
7	1044	-0.42	1.15	0.36	1.57
7	2309	-0.49	0.97	0.26	1.47
8	1134	-0.42	1.07	0.37	1.50
9	0	-0.34	1.12	0.38	1.46
9	1225	-0.49	1.05	0.25	1.54
10		Gage Inoperative			
10	1315	-0.55	0.71	0.08	1.26
11	140	-0.49	0.81	0.15	1.30
11	1406	-0.39	0.64	0.14	1.03
12	231	-0.01	1.03	0.52	1.04
12	1456	-0.02	1.01	0.48	1.03
13	321	0.05	1.08	0.53	1.03
13	1546	-0.19	0.73	0.29	0.92
14	412	-0.23	0.75	0.25	0.98
14	1637	-0.40	0.38	0.02	0.79
15	502	-0.29	0.55	0.15	0.83
15	1727	-0.37	0.30	0.00	0.67
16	552	-0.23	0.70	0.22	0.93
16	1817	-0.39	0.45	0.03	0.84
17	643	-0.28	0.57	0.14	0.85
17	1908	-0.44	0.43	0.00	0.87
18	733	-0.37	0.52	0.08	0.88
18	1958	-0.32	0.48	0.10	0.80
19	823	-0.24	0.81	0.26	1.06
19	2049	-0.37	0.57	0.11	0.94
20	914	-0.49	0.63	0.08	1.12
20	2139	-0.25	0.62	0.16	0.87
21	1004	-0.32	0.80	0.25	1.12
21	2229	-0.33	0.68	0.17	1.01
22	1055	-0.28	0.74	0.22	1.02
22	2320	-0.20	0.77	0.29	0.97
23	1145	-0.35	0.77	0.21	1.12
24	10	-0.37	0.65	0.12	1.01
24	1235	-0.53	0.52	-0.01	1.05
25	101	-0.41	0.48	0.05	0.89
25	1326	-0.46	0.50	0.02	0.96
26	151	-0.32	0.54	0.11	0.86
26	1416	-0.13	0.77	0.27	0.89
27	241	0.19	0.95	0.57	0.76
27	1507	0.10	1.03	0.55	0.93
28	332	0.08	1.15	0.56	1.07
28	1557	-0.25	0.78	0.28	1.03

FRF Tide Heights

Feb 1993

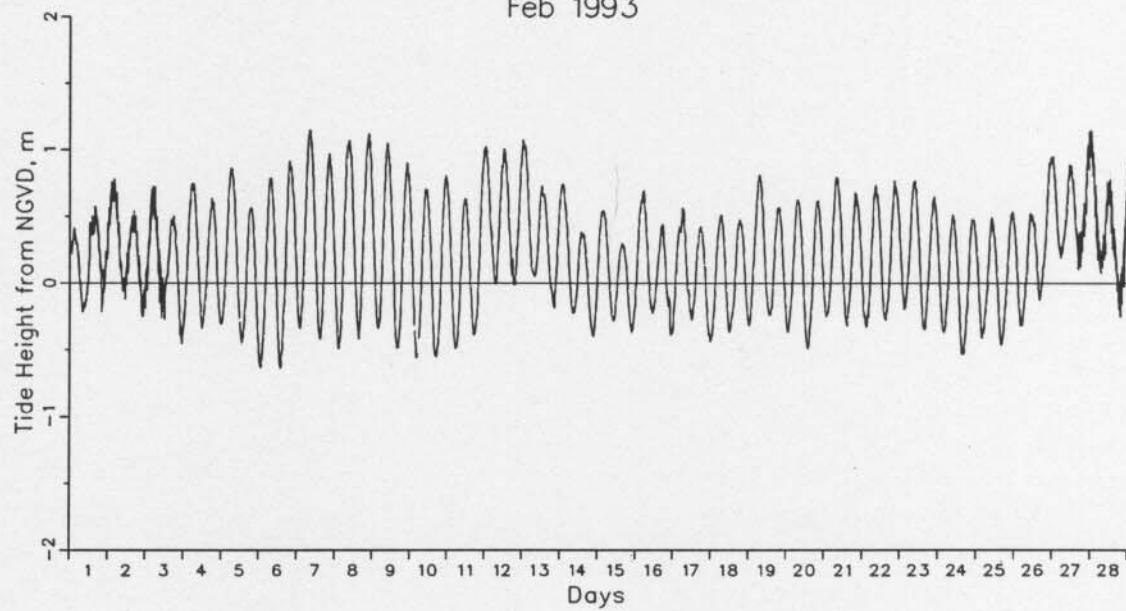


Figure 4. Water level time history

Monthly Water Levels,m NGVD

Extreme Low = -0.64 on day 6 at 1248 EST
Extreme High = 1.15 on day 7 at 706 EST
Monthly Mean = 0.22
Mean Low = -0.29
Mean High = 0.73
Mean Range = 1.02

PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in January 1993 and the survey in February 1993 on profile line 188, located 517 m south of the pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1993. Cross-hatched areas indicate changes to the annual envelope which occurred in February.

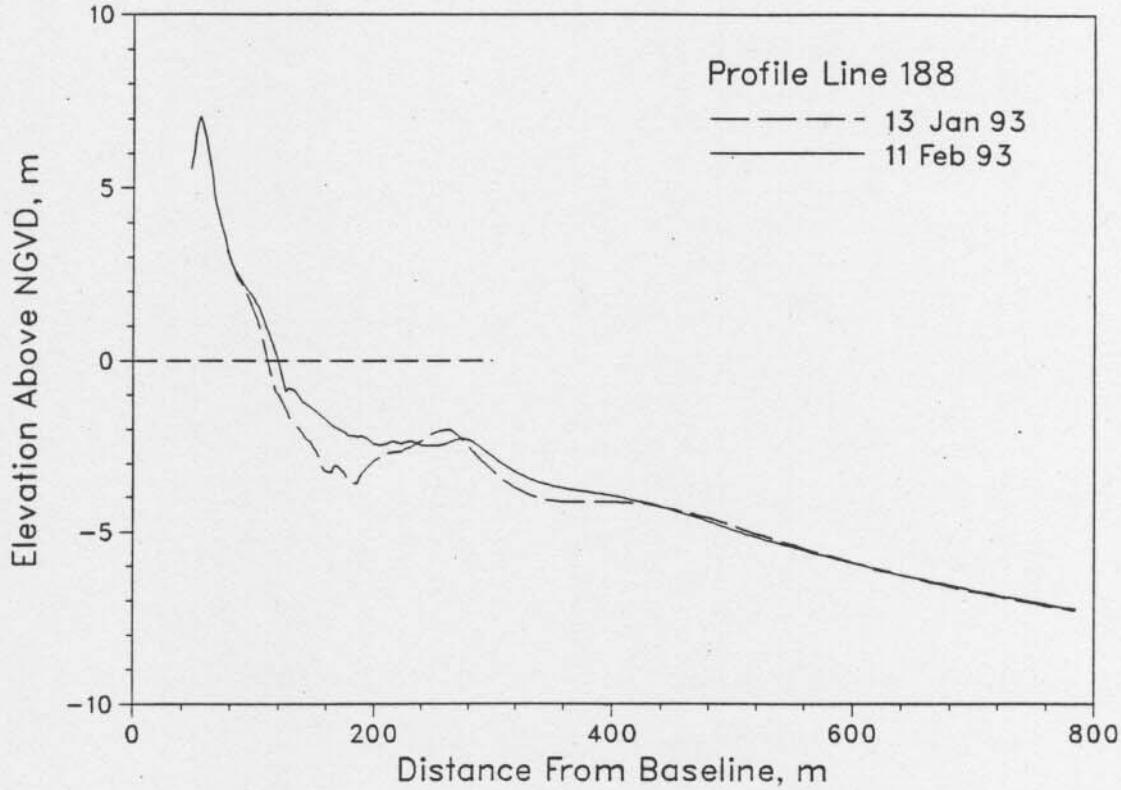


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

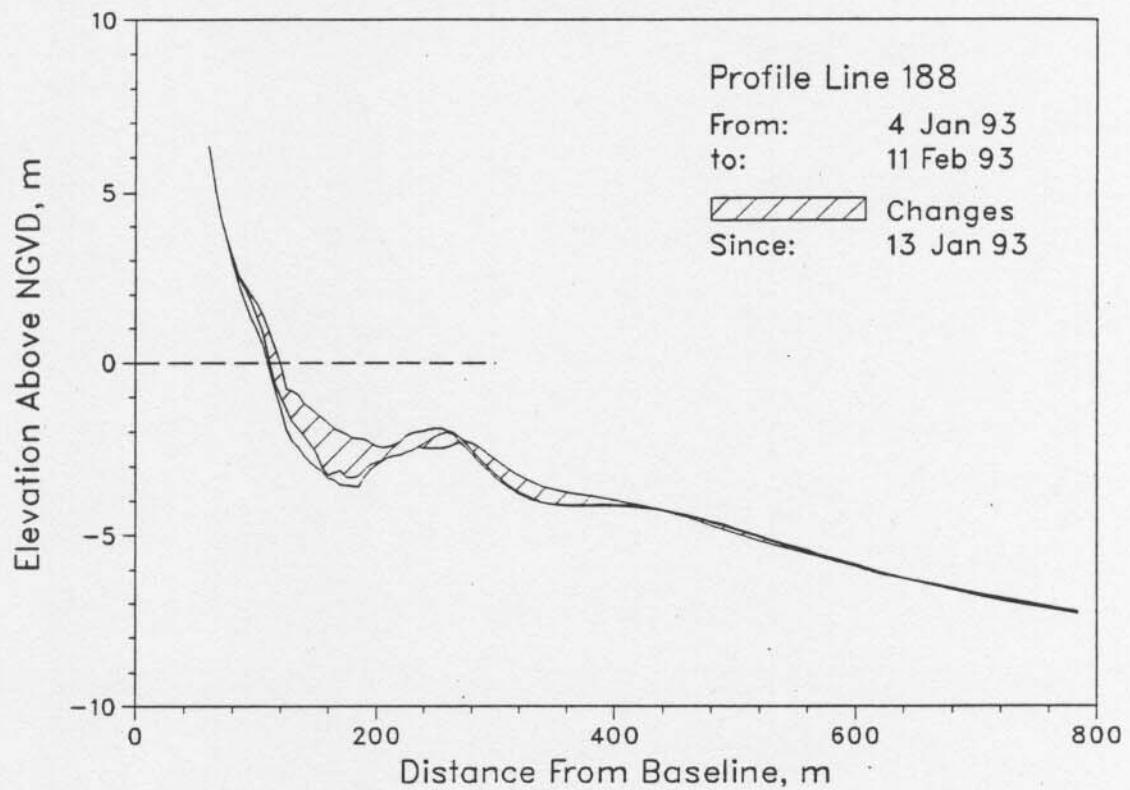


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 11 February. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

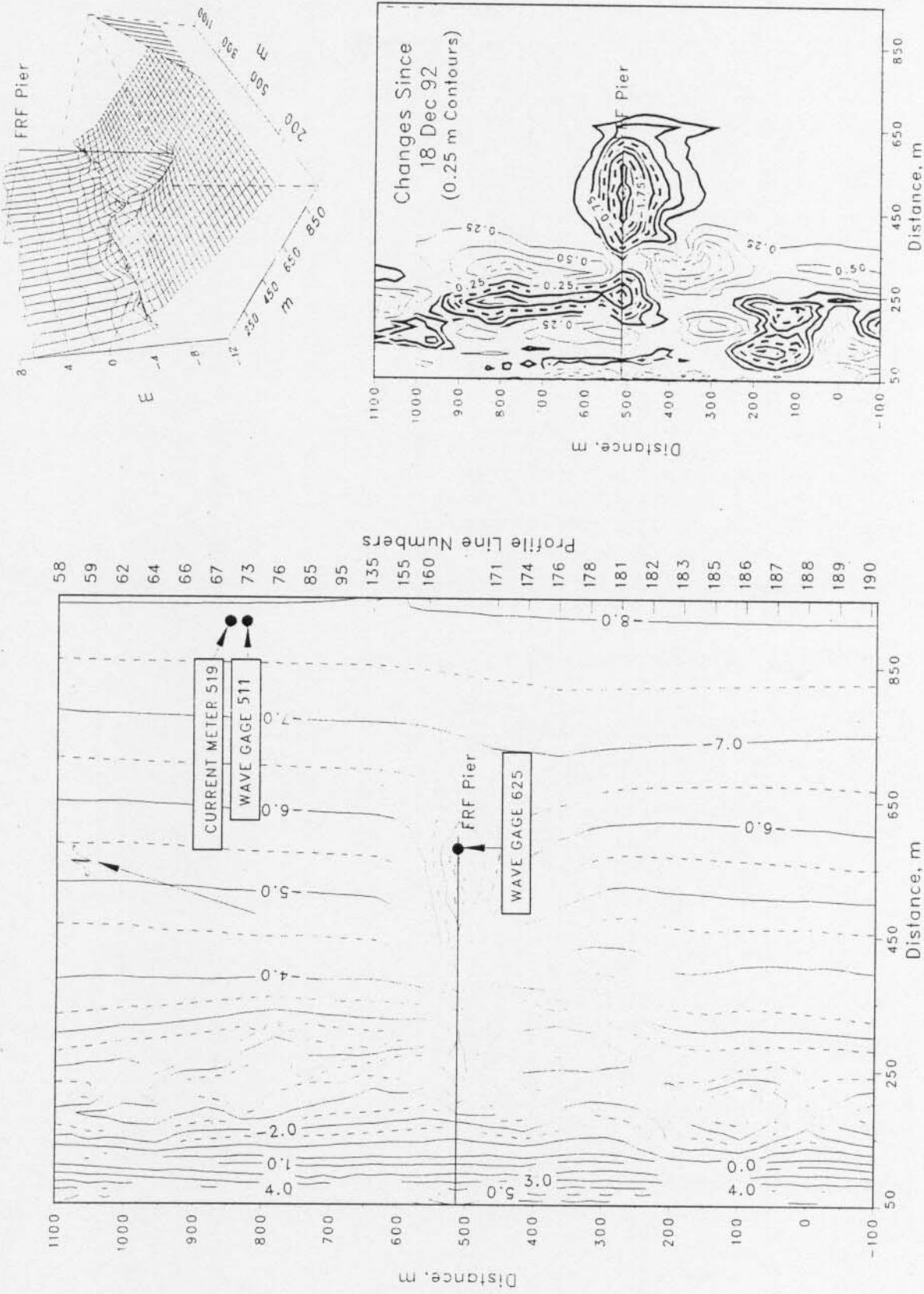


Figure 7. FRF bathymetry 11 Feb 93 depths relative to NGVD

PART VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier (i.e. as measured near the end of the pier) exceeded 2 m.

<u>Start</u>	<u>End</u>
1 February (1600)	4 February (0100)
12 February (0016)	12 February (1900)
26 February (1816)	End of month

B. Storm Synopsis.

1-4 February - Northerly winds were funnelled between a Canadian high pressure system over Ontario and a low pressure system just off the coast of Maine. The slow moving storm intensified as it moved out to sea, remaining far from the FFR. Waves generated by the storm system, far out at sea, reached a maximum H_{mo} of 2.7 m ($T_p = 14.2$ s) at 0842 EST on 3 February, at gage 625. Winds came dominantly from the north reaching speeds of 17 m/s. There were no onshore winds to report. Because the storm remained well offshore the atmospheric pressure was unaffected. There was no precipitation.

12 February - A weak low pressure system that formed off the coast of South Carolina, passed directly over Cape Hatteras producing maximum onshore winds of 13.7 m/s at 0242 EST on 12 February. Waves at gage 625 reached a maximum H_{mo} of 2.7 m ($T_p = 10.67$ s) at 0734 EST on 12 February. Atmospheric pressure remained near 1000 mb. There was 7 mm of precipitation.

26-28 February - Developing off the South Carolina coast during the day of 26 February, this storm slowly moved to the Northeast about 250 km offshore of Cape Hatteras. Waves at gage 625, reached a maximum H_{mo} of 2.9 m ($T_p = 10.67$ s) at 1216 EST on 27 February. Onshore winds reached 15.7 m/s at 2042 on 26 February. Atmospheric pressure was unaffected. There was 24 mm of precipitation. This storm actually continued into the next month but quickly died down on 1 March.

Distribution List

Government Agencies:

Back Bay National Wildlife Refuge	U.S. Geological Survey
USACE-OCE	U.S. Library of Congress
USACE-SAD	U.S. National Park Service
USACE-NAP	U.S. National Weather Service
USACE-SAW	U.S. Naval Academy
USACE-WES	U.S. Naval Civil Eng. Lab
NAVSAC	U.S. Naval Oceanographic Off.
NOAA/NOS/OMS	U.S. Naval Research Lab
National Marine Fisheries	

Colleges/Universities:

Bucknell University	Scripps Institution of Oceanography
California Inst. of Tech.	Stockton State College
Duke Marine Lab	University Calif-Berkeley
East Carolina University	University of Florida
Florida Inst. of Tech.	University of Maryland-College Park
M.I.T.	University of Maryland-Baltimore
Naval Post Graduate School	University of North Carolina
NC State University	University of N C-Seagrant Program Old
Dominion University	University of Virginia
Oregon State University	Va. Inst. of Marine Science
Prince George's College	Rutgers University

Others:

Allied Signal Aerospace Co.	WCTI-TV
Applied Physics Lab	MEC Systems Corporation
Cape Hatteras Nat. Seashore	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	N.C. Div. Coastal Management
Coastal Science & Eng., Inc.	Oregon Inlet & Waterways Commission
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Foreign:

Christchurch, Barbados
Ministry of Works, Bahamas
Dalhousie University, Halifax Nova Scotia
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of Sydney (Australia)